Synthesis of Biomass-derived Fluorescent Carbon dots and their Application

Synopsis
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1.1. Introduction:

Biomass refers to organic materials derived from living or recently living organisms, such as plants, animals, and microorganisms.These materials can be used as a source of energy, chemicals, and materials. Biomass is renewable and can be replenished relatively quickly compared to fossil fuels. It encompasses a wide range of feedstocksincluding which include plant Biomass, animal biomass and microbial biomass.Biomass continues to play a significant role in the transition towards a more sustainable and low-carbon energy future, offering diverse opportunities for energy generation, carbon management, and rural development [1-5].

Carbon-based nanomaterials have emerged as promising candidates with diverse applications in biomedical, environmental, and materials fields. Among them, carbon dots (CDs) due to their distinctive qualities, such as excellent and tunable photoluminescence (PL) efficiency, low toxicity, notable biocompatibility, low cost, simple preparation, facile functionalization, substantial pore sizes, and high specific surface areas, have attracted the most attention. The typical CDs are defined as zero-dimensional fluorescent carbon nanoparticles with a size below 20 nm, consisting of a graphitic and turbostratic sp^2/sp^3 carbon core with different functional groups (e.g., -COOH, -OH, and $-NH_2$) on the surface. [6-7] They are mainly synthesized using top-down and bottom-up approaches. Several organic as well as natural precursors have been utilized for the synthesis of carbon dots. Some of the biomass explored are beet root juice,[8] walnut peel,[9] garlic,[10] papaya juice,[11] rice husk,[12]

wintermelon,[13] lychee seeds,[14] goose feather,[15] silkworm chrysalis,[16] bee pollen,[17] milk,[18] etc. These biomass derived CDs possess excellent fluorescent properties and have been successfully applied to biological imaging, sensing, drug delivery, and other applications. Figure 1, illustrates various synthetic approaches for Carbon dots formation.

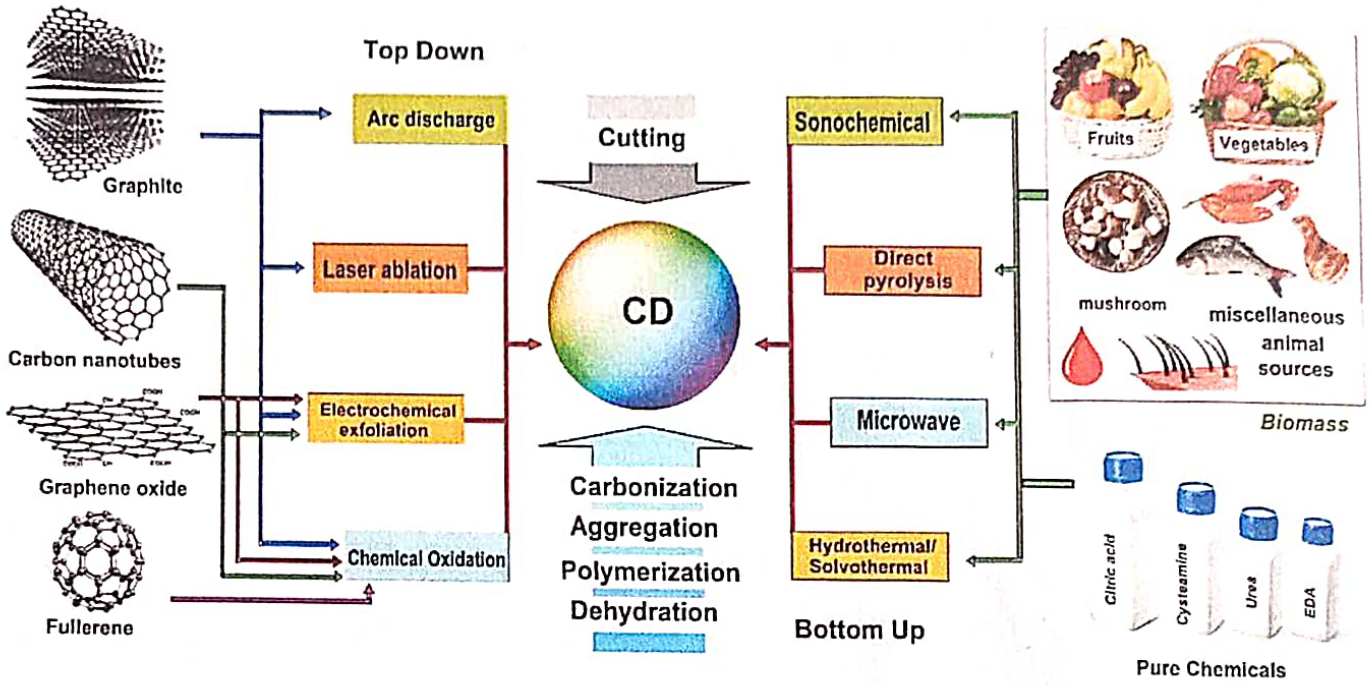


Figure 1: Various synthetic approaches for Carbon dots formation.

Several reports of Fluorescent CDs from natural biomass as precursors and their applications in both material and biomedical fields have been published. Work on fluorescent CDs from natural sources have been reviewed and complied from time to time nationally. Kurian and Paul published a review on recent trends in the use of green sources for carbon dot synthesis in which they have presented an overview of the various methods and precursors used in the synthetic strategies of carbon dots, with emphasis on green synthesis.[19] Selvan et. al. reviewed the recent progress on the different synthesis methods of biomass derived CQDs and their luminescence mechanism. They have described potential applications of these CQDs for cancer theranostics.[20] Putheyidath and group reported a review summarizing the research

and development related to the synthesis, properties, and applications of biomass-derived CDs. Further, they have discussed diverse biomedical applications (bioimaging, sensing, drug delivery, phototherapy, and nanomedicine) of CDs.[21] Gosawmi et. al. published a brief survey on the recent developments of strategies deployed for the preparation of bioderived NCQDs with emphasis on the synthetic methodology, choice of precursors, and purification strategies. Further, characterization, properties, and applications of the selected NCQDs have been highlighted along with present status and challenges.[22] Sunil et. al. reported an up-to-date review on carbon dots from eco□friendly precursors and their application as optical sensors. In their review they have highlighted the several advantages of green resources for synthesis of carbon dots. The recent developments have been concisely illustrated with several figures and tables.[23]

Although, biomass derived carbon dots have an edge over those carbon-based nanomaterials synthesized from chemical precursors in terms of environmental friendliness, however still the weak photophysical properties limit their applications. Hence there is a need for synthesis of more biomass derived carbon dots with focus on improvement of their luminescent properties and exploration of their applications.

1.2 Methodology of the study in brief:

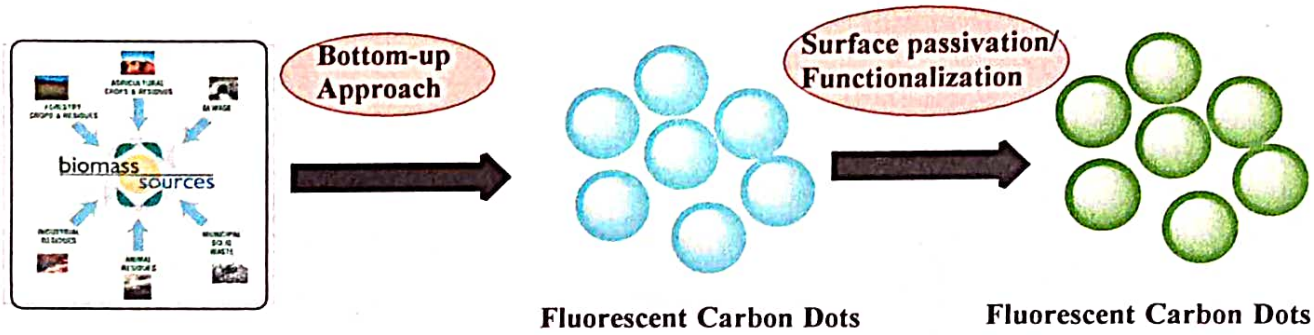
1.2.1. Preparation of Carbon Dots (CDs): Synthesis of CDs from Biomass will be done as represented in scheme 1 and 2.

Scheme 1:

In this scheme, we propose to synthesize carbon dots by utilizing biomass for the preparation of fluorescent carbon dots by bottom-up method.

Scheme 2:

In this scheme, we propose to further enhance the fluorescent properties of CDs derived from various parts of *Ficus benghalensis*tree by surface passivation and functionalization.



1.2.2. Characterization of CDs: The morphology and core size of synthesized CDs will be determined using high resolution transmission electron microscopy (HR-TEM). X-ray photoelectron spectroscopy (XPS) and FT-IR analyses will be used to determine surface functionalities.

1.2.3. Photophysical analysis: Photophysical properties of synthesized CDs will be studied using UV-Visible and Fluorescence spectroscopy.

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